9.1.2 Chemistry

Course Code: BCHCT-131	Course Title: Atomic Structure, Bonding, General Organic Chemistry and Aliphatic Hydrocarbons	Credits: 4

Bohr's Theory: Earlier Atomic Models; Dalton, Thomson and Rutherford Models; Bohr Atom Model: Calculation of Radius of Orbits, Energy of an Electron in an Orbit; Hydrogen Atom Spectrum and Bohr's Theory; Critical Analysis and Limitations of Bohr's Theory, Sommerfeld Modification.

Dual Behaviour of Radiation and Matter: The Nature of Radiation: Light as an Electromagnetic Wave, Particle Nature of Radiation; Nature of Matter: de-Broglie's Relation, Matter Waves, Davisson and Germer Experiment; Heisenberg Uncertainty Principle.

Quantum Mechanical Approach: Need for a New Approach to Atomic Structure; What is Quantum Mechanics?: Postulates of Quantum Mechanics,Observables and Operators, Eigenfunctions, Eigenvalues; Time-independent Schrödinger Equation; Significance of ψ and ψ^2, Applications of Schrödinger Equation: Energy States of the Hydrogen-like Atoms.

Hydrogen Atom: Schrödinger Equation for Hydrogen Atom, Significance of Quantum Numbers; Radial Distribution Functions, The Most Probable Distance; Angular Dependence of the Wave Function and Shapes of Atomic Orbitals; Radial and Angular Nodes and their Significance; Discovery of Spin, Spin Quantum Number (*s*), Magnetic Spin Quantum Number (m_s)

Electronic Configuration of Multi-Electron Atoms: Energy Levels for Multi-Electron Atoms; Rules for Filling of Electrons in Various Orbitals,The aufbau Principle, Hund's Rule, Pauli Exclusion Principle; Electronic Configuration of Some Multi-Electron Atoms, Stability of Half-Filled and Completely Filled Orbitals, Concept of Exchange Energy, Anomalous Electronic Configurations.

Ionic Bond: Chemical Bonding: Basic Concepts, Effective Nuclear Charge, Ionisation Energy, Electron Affinity, Electronegativity; Ionic Bond, Characteristics of Ionic Compounds, Ionic Radii, Lattice Energy; Solubility and Solvation Energy; Polarising Power and Ploarisability of Ions, Fajan's Rules;The Bonding Continuum; Bond Polarity, Dipole Moments, Determination of Dipole Moment, Application of Dipole Moment Studies.

Covalent Bond: Classical Theory of Covalent Bond, Lewis Concept of Covalent Bond, Writing Lewis Structures, Formal Charge: Predicting Preferred Lewis Structure, Coordinate Covalent Bonds; Characteristics of Covalent Compounds, Covalent Bond Parameters; Molecular Geometry: Valence Shell Electron Pair RepulsionTheory, Central Atom havingonly Bond Pairs, Central Atom having Bond Pairs and Lone Pairs, Central Atom having Multiple Bonds.

Valence Bond Theory: The Origin of Valence Bond and Molecular Orbital Theories; Principles of Valence Bond Theory; Valence Bond Theory of Hydrogen Molecule; Resonance or Electron Delocalisation; Resonating Structures; Hybridisation of Orbitals.

Molecular Orbital Theory: Molecular Orbital Theory, LCAO method, Bonding and Antibonding Molecular Orbitals, Molecular Orbitals and their Characteristics, *s-s* combination of Atomic Orbitals, *s-p* combination of Atomic Orbitals, *p-p* combination of Atomic Orbitals, Non-bonding combination of Atomic Orbitals; Rules for Linear Combination of Atomic Orbitals;

Molecular Orbital treatment of Homonuclear Diatomic Molecules; Heteronuclear Diatomic Molecules; Comparison of Valence Bond and Molecular Orbital Theories.

Stereochemistry I: Geometrical and Optical Isomerisms: Isomerism; Geometrical Isomerism, *cis*–, *trans*–Nomenclature, *E/Z* Nomenclature, Cahn-Ingold-Prelog Rules; Characterisation of Geometrical Isomers; Optical Isomerism; Plane Polarised Light and Optical Activity, Origin of Optical Activity; Chirality, Enantiomers, Diastereomers, *Meso* Compounds.

Sterochemistry-II: Configurational Isomers: Configuration and Fischer Projection Formulae; Configurational Notations, *R/S System, Erythro* and *threo Nomenclature;* Racemic Mixtures and their Resolution.

Sterochemistry-III: Conformational Isomerism: Conformational Isomers: Newman and Sawhorse Representations; Conformations of Ethane; Conformations of Butane; Conformations of Cyclic Systems, Conformations of Cyclohexane.

Structure - Reactivity Relationships: What are Acids and Bases?; Strengths of Acids and Bases; Factors Affecting the Strengths of Acids and Bases, Inductive Effect, Resonance Effect, Hyperconjugation, Hydrogen Bonding, Steric Effect; Tautomerism.

Reactions and Reactive Intermediates: Cleavage of Bonds, Bond Heterolysis, Bond Homolysis; Types of Reagents, Nucleophiles, Electrophiles; Types of Reactions, Substitution Reactions, Addition Reactions, Elimination Reactions, Polymerisation Reactions; Reactive Intermediates, Carbocations, Carbanions, Free Radicals.

Alkanes: Petroleum: A Source of Alkanes, Composition of Petroleum; Physical Properties; Preparation of Alkanes and Cycloalkanes, Wurtz Reaction, Kolbe's Electrolytic Method, Hydrogenation of Unsaturated Hydrocarbons,Reduction of Alkyl Halides; Decarboxylation of the Carboxylic Acids, Preparation of Cycloalkanes; Reactions of Alkanes, Halogenation, Nitration, Isomerisation, Aromatisation, Pyrolysis, Reactions of Small Ring Compounds.

Alkenes-I: Alkenes and their Classification; Physical Properties; Preparation of Alkenes, Dehydrohalogenation of Alkyl Halides, Dehydration of Alcohols, Hydrogenation of Alkynes, Preparation of Dienes.

Alkenes-II: Reactions of Alkenes, Halogenation, Hydrohalogenation, Hydration, Oxymercuration-demercuration Reaction, Hydroboration, Ozonolysis, Hydroxylation.

Alkynes: Alkynes and their Types; Physical Properties and Uses; Preparation of Alkynes, Dehydrohalogenation of Dihalides, Dehalogenation of Tetrahalides, Alkylation of Ethyne; Reactions of Alkynes, Hydrogenation, Hydrohalogenation, Halogenation, Hydration, Ozonolysis, Hydroboration,

Aromaticity: Aromatic Compounds- an Introduction; Physical Properties; IUPAC Nomenclature of Aromatic Compounds, Nomenclature of Benzene and its Derivatives, Disubstituted Benzenes; Structure of Benzene; Resonance, Molecular orbital model of benzene, Representation of Benzene Ring; Aromaticity, Cyclobutadiene, Cyclopentadiene, Benzene, Cyclooctatetraene.

Course Code: BCHCL-132	**Course Title: Chemistry Lab I: Atomic Structure, Bonding, General Organic Chemistry and Aliphatic Hydrocarbons**	**Credits: 2**

Titrimetry: An Introduction: Introduction: Apparatus Commonly Used, How to Use a Pipette,

How to Use a Burette, How to Use a Volumetric Flask, How to Use an Analytical Balance; Expression of Concentration; Standard Solution; Titration, Types of Indicators,Types of Titrations; Instrumental Determination of Equivalence Point; Safety Measures in the Laboratory.

List of Experiments:

Experiment 1: Determination of Sodium Carbonate and Sodium Hydrogen Carbonate in a Mixture by indicator method

Experiment 2: Estimation of Oxalic Acid by Redox Titration

Experiment 3: Estimation of Water of Crystallisation in Mohr's Salt

Experiment 4: Estimation of Copper ions by Chromatometry using internal indicator

Experiment 5: Estimation of Copper Iodometrically

Experiment 6: Detection of Extra Elements (N, S, X) in the Organic Compounds

Experiment 7: Separation and Identification the Components of a given Mixture of Amino Acids by Paper Chromatography

Experiment 8: Separation and Identification the Sugars present in the given Mixture by Paper Chromatography.

Course Code: BCHCT-133	**Course Title: Chemical Energetics, Equilibria and Functional Group Organic Chemistry I**	**Credits: 4**

Chemical Energetics: Thermodynamics and its Importance; Thermodynamic Terminology; Thermodynamic Processes, Work, Heat and Heat Capacity; Thermodynamic reversibility; The Zeroth Law of Thermodynamics.

The First Law of Thermodynamics: Heat Changes Under Constant Volume;

Internal Energy; Work of Expansion; Heat Changes Under Constant Pressure; Enthalpy and Enthalpy Changes.

Thermochemistry: Energy Changes in Chemical Reactions; Calorimetry, Thermochemical Equations, Standard Enthalpy Changes, Relationship between $\Delta_r U$ and $\Delta_r H$; Standard enthalpy of formation and its determination; Enthalpy Changes in Different types of Reactions; Kirchhoff's Equation; Bond Enthalpies, Bond Dissociation Enthalpy, Estimation of Enthalpies of Reaction and Formation.

Second and Third Laws of Thermodynamics:Spontaneous Processes, Enthalpy and Spontaneity, Entropy, Entropy and Spontaneity, Statements of the Second Law of Thermodynamics, The Third Law of Thermodynamics, Determination of Absolute Entropy, Concept of Residual Entropy.

Chemical Equilibrium I: Reversible and Irreversible Reactions, Gibb's Energy Change in a Chemical Reaction, Distinction between ΔG and ΔG^0 Chemical Equilibrium in Ideal Gas Mixtures, Thermodynamic Derivation of Law of Chemical Equilibrium, Equilibrium constants and relationship between K_p, K_x, K_c.

Chemical Equilibrium II: Application of Equilibrium Studies, Le-Chatelier Principle, Effect of Change in Concentration, Pressure and Temperature, effect of addition of Inert Gas / Catalyst.

Ionic Equilibrium I: Electrolytes and Non-Electrolytes, Strong and Weak Electrolytes, Degree of Ionization and Factors Affecting Degree of Ionization, Ionization Constant and Ostwald's Dilution Law, Review of Theories of Acids and Bases, Ionic Product of Water, $K_{w,}$ pH Scale and Calculation of pH.

Ionic Equilibrium II: Ionisation Constants of Weak Acids and Bases, Ionisation of Diprotic and Polyprotic Acids; Strength of Acids and Bases, Common Ion Effect, Buffer Solutions, Buffer Action.

Ionic Equilibrium III: Salt Hydrolysis, Hydrolysis Constant and Degree of Hydrolysis, Acidic, Basic and Neutral Salts, pH of Salt Solutions, Solubility and Solubility Product of Sparingly Soluble Salts, Applications of Solubility Product Principle.

Preparation of Aromatic Compounds: Aromatic Hydrocarbons: An Introduction; Nomenclature: A Recall; Structure of Benzene: A Recall; Physical Properties, Isolation of Benzene; Preparations of Benzene, From Phenol, By Decarboxylation, From Acetylene, From Benzene Sulphonic Acid.

Reactions of Aromatic Hydrocarbons-I: Electrophilic Substitution; General Mechanism of Electrophilic Substitution Reactions; Reactions of Benzene, Nitration, Halogenation, Sulphonation, Friedel-Craft's Alkylation and its Limitations; Friedel-Craft's Acylation.

Reactions of Aromatic Hydrocarbons-II: Effect of Substituents on Reactivity; Activators and Deactivators; Effect of Substituents on Orientation, Ortho and Para-Directing Activator, Meta-Directing Deactivator, Ortho and Para-Directing Deactivator; Reactions of Side-Chain of Benzene, Oxidation of Side-Chain.

Alkyl Halides: Classification of Halogen Derivatives; Preparation of Alkyl Halides; Structure and Properties of Halogen Derivatives, Structure of Halogen Derivatives, Physical Properties of Halogen Derivatives, Chemical Properties of Alkyl Halides; Uses of Alkyl Halides; Lab Detection.

Aryl Halides: Structure and Reactivity; Preparation of Aryl Halides, From Aromatic Hydrocarbon, From Aromatic Amide; Reaction of Aryl Halides, Nucleophilic Substitution by Addition-Elimination, Nucleophilic Substitution via a Benzene Intermediate, Electophilic Substitution Reactions, Reactions due to C–X bond; Reactivity and Relative Strength of C–X Bond in Halogen Derivatives.

Alcohols: Classification of Alcohols; Structure of Alcohols; Preparation of Alcohols,

General Methods of the Preparation of Alcohols, Commercial Preparations of Alcohols; Physical Properties; Chemical Properties, Acidity and Basicity of Alcohols, Reaction of the O–H Bond, Reaction of the C–O Bond; Oxidation of Alcohols; Diols; Lab Detection.

Phenols: Structure and Reactivity; Physical Properties; Preparation of Phenol; Chemical Properties, Acidity and Basicity of Alcohols and Phenol, Reactions of Phenols, Reactions due to Hydroxyl Group, Reactions due to Aromatic Ring, Oxidation of Phenols, Condensation Reaction, Coupling Reaction, Libermann's Nitroso reaction.

Ethers: Classification; Preparation of Ethers, Preparation of Open Chain Ethers, Preparation of Epoxides; Properties of Ethers, Physical Properties, Reactions of Open Chain Ethers, Reactions of Epoxides; Crown Ethers and Kryptands(as good hosts); Industrial Uses.

Aldehydes And Ketones: Structure and Physical and Properties, Structure of the Carbonyl Group, Physical Properties; Preparation, General Methods of Preparation, Industrial Methods of Preparation of Aldehydes and Ketones; Reactions of Aldehydes and Ketones, Addition Reactions, Reactions Involving α-Hydrogen, Oxidation, Reduction, Condensation, Specific Reactions of Aldehydes and Ketones; Industrial Uses.

Aromatic Aldehydes And Ketones:Preparation of Bezaldehyde and Phenylethanone; Structure and Properties of Aryl aldehydes and ketones

Course Code: BCHCL-134	**Course Title: Chemistry Lab II: Chemical Energetics, Equilibria and Functional Group Organic Chemistry I**	**Credits: 2**

Thermochemistry and Determination of Enthalpy of Neutralisation: Some Fundamental Concepts; The First Law of Thermodynamics; The Enthalpy of a Reaction; The Enthalpy of Neutralisation

List of Experiments:

Experiment 1a: Determination of the Heat Capacity of the Colorimeter, Heat Exchange Method

Experiment 1b: Determination of the Enthalpy of Neutralisation of, Hydrochloric Acid with Sodium Hydroxide

Experiment 2: Determination of the Enthalpies of Neutralisation and Ionisation of Acetic Acid The Enthalpy of Solution:

Experiment 3: Determination of the Integral Enthalpy of Solution of Ammonium Chloride

Experiment 4: Determination of enthalpy of hydration of copper sulphate.

Experiment 5: Study of the solubility of benzoic acid in water and determination of ΔH.

Experiment 6: Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps using pH-meter.

Experiment 7: Preparation of buffer solutions: (i) Sodium acetate-acetic acid (ii) Ammonium chloride-ammonium hydroxide.

Experiment 8: Purification of organic compounds by crystallization (from water and alcohol) and distillation.

Experiment 9: Criteria of Purity: Determination of melting and boiling points.

Experiment 10: Bromination of Phenol/Aniline

Experiment 11: Benzoylation of amines/phenolsExperiment 12: Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

Course Code: BCHCT-135	Course Title: Solutions, Phase Equilibrium, Conductance, Electrochemistry and Functional Group Organic Chemistry-II	Credits: 4

Solutions-I: Types of Solutions; Different Modes of Expressing Concentration of Solution; Solutions of Solids in Liquids; Solutions of Gases in Liquids; Ideal Solutions, Raoult's Law, Raoult's Law curves, Thermodynamics of Ideal Solutions; Non-ideal Solutions, Raoult's Law Curves; Vapour Pressure Variation with Liquid and Vapour Composition (for Ideal and Non-ideal Solutions); Boiling Point Diagrams – Temperature - Composition Curves (for Ideal and Non-ideal Solutions), Distillation of Ideal Solutions, Lever Rule, Distillation of Solutions exhibiting Positive and Negative Deviations- Azeotropes.

Solutions-II: Partially Miscible Liquid Systems, Critical Solution Temperatures, Effect of Impurity on Partial Miscibility of Liquids; Immiscible Liquid Pairs, Principle of Steam Distillation; Nernst Distribution Law and its Applications, Nernst Distribution Law ,Dissociation of A Solute in one of the Solvents, Association of a Solute in one of the Solvents, Solvent Extraction.

Phase Equilibrium-I: Definition of the Terms; Phases, Components, Degrees of Freedom of a System; Criteria for Phase Equilibrium; Gibbs Phase Rule and its Thermodynamic Derivation; Derivation of Clausius-Clapeyron Equation and its Importance in Phase Equilibria.

Phase Equilibrium-II: Application of Phase Rule to One Component Systems, Phase Diagram of Water, Phase Diagram of Sulphur; Application of Phase Rule to Two Component Systems, Phase Rule for Two Component Systems, Simple Eutectic System,(Pb-Ag system), System involving Congruent Melting Point, ($FeCl_3$ -H_2O system), System involving Incongruent Melting Point (Na-K system).

Conductance-I: Electrolytic Conductance; Molar Conductivity; Molar Conductance at Infinite Dilution, (Variation with Dilution for Strong and Weak Electrolytes); Molar Conductance for Strong electrolytes, Kohlrausch Law of Independent Migration of Ions.

Conductance-II: Ionic Mobilities and Transference Number; Determination of Transference Number, Hittorf Method, Moving Boundary Method; Application of Conductivity Measurements, Determination of Degree of Ionisation of Weak Electrolytes, Determination of Solubility and Solubility Products of Sparingly Soluble Salts, Determination of Ionic Product of Water, Determination of Hydrolysis Constant of a Salt,ConductometricTitrations (Acid - base).

Electrochemistry-I: Reversible and Irreversible Cells; Concept of EMF of a Cell, Experimental Measurement of EMF; Standard Electrode Potential, Electrochemical Series; Electrochemical Cell Representation and Cell Reaction; Types of electrodes, Metal-Metal Ion Electrodes, Gas Electrodes, Amalgam Electrode, Metal-Insoluble Salt Electrode, Membrane Electrode, Redox Electrode; Nernst Equation and its Importance; Thermodynamics of a Reversible Cell, Calculation of Thermodynamic Properties: ΔG, ΔH and ΔS from EMF data; Calculation of Equilibrium Constant from EMF Data.

Electrochemistry-II: Types of Galvanic Cells, Chemical Cells and Concentration Cells ; Concentration Cells With Transference and Without Transference; Liquid Junction Potential and Salt Bridge; Applications of EMF Measurements, pH Determination, using Hydrogen Electrode, using Quinhydrone Electrode, Potentiometric Titrations-Qualitative treatment, (Acid-base and Oxidation-reductiononly); Electrolytic Cells, Faraday's Law of Electrolysis; Applications of Electrolysis.

Carboxylic Acids: Structure and Reactivity; Physical Properties; Preparation of Carboxylic Acids; Reactions of Carboxylic Acids, Conversion to Alkanoyl Halides, Esterification, Conversion to Amides, Hell-Vohlard-Zelinsky Reaction, Reduction, Decarboxylation.

Carboxylic Acid Derivatives: Structure and Reactivity of Carboxylic Acid Derivatives; Physical Properties of Carboxylic Acid Derivatives; Carboxylic Acid Halides, Preparation of Carboxylic Acid Halides, Reactions of Carboxylic Acid Halides; Carboxylic Acid Anhydrides, Preparation of Carboxylic Acid Anhydrides, Reactions of Carboxylic Acid Anhydrides; Carboxylic Acid Esters, Preparation of Carboxylic Acid esters, Reactions of Carboxylic Acid esters, Reformatsky Reaction; Amides, Preparation of Amides, Reactions of Amides.

Amines: Structure and Reactivity of Amines; Physical Properties of Amines; Preparation of Amines; from Alkyl Halides, from Gabriel's Phthalimide Synthesis, from Hofmann Bromamide Degradation; Reactions of Amines, Hofmann elimination, Schotten-Baumann Reaction; Reaction of aliphatic amine with HNO_2; Electrophilic Substitution (of Aniline), Nitration, Bromination, Sulphonation; Laboratory Detection of Amines, Carbylamine Test, Hinsberg Test.

Diazonium Salts: Preparation from Aromatic Amines; Reactions of Diazonium Salts, Conversion to, Benzene, Phenol, Sandmeyer Reaction, Dyes.

Amino Acids and Peptides; Structure and Physical Properties Amino Acids, Zwitter Ion, Isoelectric Point and Electrophoresis (+optical activity in brief): Synthesis of 2-Amino Acids: Gabriel's Phthalimide Synthesis, Strecker Synthesis; Structure of Peptides; Synthesis of Peptides, Synthesis by N-protection, *t*-Butyloxycarbonyl (Boc) Group, Phthaloyl Group, Synthesis by C-Activating Groups; Merrifield Solid-Phase Synthesis; Lab Detection of Amino Acids, Complexation with Cu^{2+}, Ninhydrin Test.

Structure of Peptides and Proteins: Overview of Primary, Secondary, Tertiary and Quaternary Structures of Proteins; Determination of Primary Structure of Peptides and Proteins, Partial Hydrolysis, End Group Analysis, N-terminal Identification by, Degradation (i) Sanger Method (ii) Edman degradation, C-terminal Identification (with Carboxypeptidase Enzyme).

Carbohydrates-I: Monosaccharides: Classification of Carbohydrates; General Properties; Structure of Glucose and Fructose; Configuration of Monosaccharides, Absolute Configuration of Glucose and Fructose, Mutarotation; Ascending and Descending of Chains in Monosaccharides.

Carbohydrates-II: Disaccharrides and Polysaccharrides: Structure of Disaccharrides, Sucrose, Cellobiose, Maltose, Lactose; Structure of Polysaccharrides, Starch, Cellulose, (Excluding their Structure Elucidation).

Course Code: BCHCL-136	**Course Title: Chemistry Lab 3: Solutions, Phase Equilibrium, Conductance, Electrochemistry and Functional Group Organic Chemistry-II**	**Credits: 2**

List of Experiments:

Experiment 1 Study of the equilibrium of one of the following reactions by the distribution method:

$I_2(aq) + I^-(aq) \rightleftharpoons I_3^-(aq)$

$Cu^{2+}(aq) + xNH_2(aq) \leftrightharpoons [Cu(NH_3)_x]^{2+}$

Experiment 2 Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.

Experiment 3 Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature

Experiment 4 Study of the effect of impurities on CST of phenol – water system

Experiment 5 Determination of dissociation constant of a weak acid.

Experiment 6 Conductometric titrations of the following:

a) Strong acid vs. strong base

b) Weak acid vs. strong base

Experiment 7 Potentiometric titrations of the following:

a) Strong acid vs. strong base

b) Weak acid vs. strong base

Experiment 8 Systematic qualitative organic analysis of organic compounds possessing functional groups: carboxylic acid, phenol, aldehydes and ketones, amide, nitro and aromatic amines preparation of their derivatives

Experiment 9 Systematic qualitative organic analysis of organic compounds possessing unknown functional group and its derivative (Five to six samples)

Experiment 10 Differentiation between a reducing and a nonreducing sugars

Experiment 11 Separation of amino acids/sugars by Paper Chromatography/ Thin Layer Chromatography (Optional)

Experiment 12 Determination of the concentration of glycine solution by formylation method.

Experiment 13 Action of salivary amylase on starch and effect of temperature on the action of salivary amylase on starch

Course Code: BCHCT-137	Course Title: Coordination Chemistry, States of Matter & Chemical Kinetics	Credits: 4

Transition Elements-I: Electronic Configuration ; General Characteristics; Periodic Trends in Properties, Atomic Radii, Atomic Volume and Density, Melting and Boiling Points, Ionisation Energy, Electronegativity, Electrode Potential, Oxidation States, Stability of various Oxidation States for Mn, Fe and Cu, Latimer diagrams.

Transition Elements-II: Formation of Complexes; Colour of Transition Metal Compounds; Magnetic Properties; Catalytic Properties.

Inner-Transition Elements: General Characteristics, Electronic Configuration and Position in Periodic Table, Lanthanide Contraction, Atomic Radii, Oxidation States, Colour of Ions, Electrode Potentials, Magnetic Properties; Separation of Lanthanides, Ion-Exchange Method.

Coordination Chemistry-I: Coordination Chemistry, Werner's Coordination Theory; Some Basic Definitions, Complex, Ligands, Coordination Number; Nomenclature, IUPAC System.

Coordination Chemistry –II : Isomerism in Coordination Compound, Structural Isomerism (Coordination Numbers 4 and 6), Stereoisomerism (Coordination Numbers 4 and 6); Theories of Bonding as applied to Complexes, Valence Bond Theory, Inner and Outer Orbital Complexes of Cr, Fe, Co, Ni and Cu.

Crystal Field Theory-I : Crystal Field Theory, Crystal Field Splitting in Octahedral Complexes, Crystal Field Stabilization Energy (CFSE); Crystal Field Effects , Weak and Strong Fields; Factors affecting the Magnitude of Crystal Field Splitting Energy, Spectrochemical Series.

Crystal Field Theory-II: Crystal Field Splitting in Tetrahedral Complexes; Comparison of CFSE for O_h and T_d Complexes; Crystal Field Splitting in Square Planar Complexes, Tetragonal Distortion of Octahedral Geometry, Jahn-Teller Distortion, Square Planar Coordination; Some common applications of Complexes.

Kinetic Theory of Gases : Recapitulation of the Gas Laws; Equation of State of Ideal Gases; Kinetic Theory of Gases, Postulates of Kinetic Theory; Kinetic Gas Equation; Maxwell Boltzmann Distribution, Molecular Velocities, Molecular Energies, Temperature Dependence of these Distributions; Principle of Equipartition of Energy; Intermolecular Collisions; Mean Free Path.

Real Gases and their Liquefaction**:** Deviation of Real Gases from Ideal Behavior, Compressibility Factor, Causes of Deviation; Van der Waals Equation, Boyle Temperature; Critical Phenomenon, Andrews Isotherms of CO_2, Critical Constants and van der Waals Constants, Determination of Critical Constants; Viscosity of Gases, Effect of Temperature and Pressure.

Liquids**:** Comparison of Liquids with Gases and Solid; Structure of Liquids; Surface Tension, Determination Surface Tension; Viscosity of a Liquid, Determination of Coefficient of Viscosity; Effect of temperature on surface tension and coefficient of viscosity of a liquid.

Solids - I: Amorphous and Crystalline Solids; Symmetry Elements; Crystal Lattice, Unit Cell; Bravais Lattices and Crystal Systems, Bravais Lattice, Cubic System Geometry; Laws of Crystallography, Law of Constancy of Interfacial Angles, Law of Rational Indices; Crystal Planes and Miller Indices.

Solids –II: X-rays Diffraction, Bragg's Law; Structures of NaCl, KCl and CsCl; Defects in Crystals; Glasses and Liquid Crystals.

Chemical Kinetics – I: Rate of a Reaction, Experimental Determination, Factors affecting Rate of a Reaction; Rate Law and Rate Constant, Order and Molecularity; Integrated Rate Laws, Zero Order Reactions, First Order Reactions, Second Order Reactions

Chemical Kinetics – II: Determining the Order of a Reaction, Initial Rate Method, Integral Method, Graphical Method, Half-life Method, Isolation Method; Theories of Reaction Rates, Collision theory, Activated Complex Theory of Bimolecular Reactions, Collision Theory and Arrhenius Theory – a Comparison.

Course Code: BCHCL-138	Course Title: Chemistry Lab IV: Coordination Chemistry, States of Matter & Chemical Kinetics	Credits: 2

List of Experiments:

1. Qualitative Inorganic Analysis of 6 known and 6 unknown samples (semi-micro qualitative analysis using H_2S of mixtures – not more than four ionic species, two anions and two cations and excluding insoluble salts)
   [Cations: NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sb^{3+}, Sb^{5+}, Sn^{4+}, Al^{3+} Cr^{3+}, Fe^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+} , K^+
   Anions: Sulphide, Sulphite, Thiosulphate, Nitrite, Acetate, Oxalate, Chloride, Bromide, Iodide, Fluoride, Nitrate, Sulphate, Phosphate, Borate Ions].
2. To determine Nickel gravimetrically as the dimethylglyoximate *or*
   To determine Aluminium gravimetrically as Aluminium 8-hydroxyquinolinate.
3. To estimate Magnesium or Zinc Ions in a mixture by complexometry *or*
   To estimate total hardness of a given sample of water by complexometric titration.
4. To draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given coloured compound ($KMnO_4$/ $CoSO_4$) and estimate the concentration of the same in a given solution. (demonstation/optional).
5. To determine the composition of the Fe^{3+}-salicylic acid complex solution by Job's method. (demonstation/optional)
6. To determine the Surface Tension of a liquid or a dilute solution using a stalagmometer.
7. To Study the Variation of Surface Tension with the Concentration of a Detergent solution.
8. To determine the Coefficient of Viscosity of a liquid or a dilute Solution by Ostwald Viscometer *or* To study the variation of Viscosity of an aqueous solution with concentration of solute.
9. To study the Kinetics of Reaction between Peroxydisulphate and Iodide Ions by Initial rate method (Iodine Clock Method)
10. To study the Kinetics of Acid Catalysed Hydrolysis of Ester – Titrimetry *or* To study the Kinetics of Saponification of Ester – Titrimetry.
11. To Compare the strengths of HCl and H_2SO_4 by studying the kinetics of hydrolysis of methyl acetate.

9.1.3 Geology

Course Code: BGYCT-131	Course Title: Physical and Structural Geology	Credits: 4

General Geology: Introduction to Geology and its relation to Earth science; Its scope and sub disciplines; Geology and its relation with other branches of science; Earth and solar system; Asteroids and meteorites; Theories regarding origin and age of the Earth; Radioactivity and its application in determining age of the Earth; Shape and structure of the Earth; Internal